

Amendment Under 37 CFR .114 (c)
USSN 10/774,614

REMARKS

Claims 1-5 and 7-21 now stand in the application, new claims 19-21 having been added. Reconsideration of the application and allowance of all claims are respectfully requested in view of the above amendments and the following remarks.

1-5, 7, 9-13, 16-18 are rejected as unpatentable over Kawano et al in view of Bernard et al. Claims 1-5, 9, 10, 16 and 17 are rejected as unpatentable over Kawano et al in view of Vandayburg et al. Claims 7 and 11-15 are rejected as unpatentable over Kawano et al in view of Bernard et al and/or Kawano et al in view of Vandayburg et al, both in further view of Miyamoto et al. Claim 8 is rejected as unpatentable over Kawano et al in view of Bernard et al and/or Kawano et al in view of Vandayburg et al, both in further view of Takemura et al. All of these rejections are respectfully traversed, for the reasons provided in the previous response as well as the reasons set forth below.

Kawano –

In the amendment filed February 6, 2008, it was pointed out to the examiner that Kawano teaches an electrode support that is corrugated and therefore is therefore three-dimensional, not two-dimensional. In the Office action mailed March 25, 2008, the examiner disagrees, pointing to lines 44-48 of column 1 of Kawano. But the passage cited by the examiner actually confirms that Kawano is directed to a three-dimensional support, and it is believed that the examiner has simply misread Kawano.

The background discussion of Kawano points out problems in the prior art. Beginning at line 23 of column 1, the patentees point out that these problems are solved by using a corrugated shape, "thereby providing a three-dimensional configuration." The authors then point out that this three-dimensional configuration has a problem that, even though the configuration of the corrugated support is three-dimensional, the surface of the substrate is still flat and smooth and there has been difficulty preventing the electrode active material layer from being separated from the electrode substrate.

Kawano seeks to solve this problem, i.e., Kawano wants to use a three-dimensional corrugated support but wants to improve the adherence of the electrode active material to the substrate. This is clear from the paragraph beginning at line 44 of column 1, where Kawano specifically states that the invention relates to an electrode wherein the substrate is worked to form a corrugated shape, i.e., the same shape Kawano refers to at line 28 of column 1 as being three-dimensional. Thus, when read carefully, it is clear that Kawano uses a three-dimensional support, not a two-dimensional support as recited in the present claims.

Applicants do not contend that two-dimensional supports were not known in the prior art, and in fact this has already been acknowledged in paragraph [003] of the specification. But the goal of the present invention is to find a suitable binder for this type of support. Kawano does indeed describe such two-dimensional supports in its background discussion, but then Kawano goes in a different direction, using a three-dimensional support. What is important to note is that when Kawano seeks to improve the adherence of the active material layer to the substrate,

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Kawano goes to a three-dimensional support, and then Kawano further improves on that. The present inventors have chosen a different solution to the problem. The present inventors have stayed with a two-dimensional support, and have sought to achieve a two-dimensional electrode having characteristics as good as an electrode having a three-dimensional support (p.2, lines 3-6 of the application). It is a specific goal of the present invention not to follow the teaching of Kawano and adopt a three-dimensional support. Instead, the present inventors have invented an improved binder.

If one of ordinary skill in the art were to consider Kawano et al, it would teach directly away from the present invention by teaching the artisan that the solution to better adherence lies in a three dimensional support. In contrast, the invention is based on the discovery that the selection of a binder which is a mixture of a cellulose compound and a styrene-acrylate copolymer improves the bonding force between the substrate and the active material and improves the mechanical behaviour of the electrode (p.10, line 16).

Kawano further teaches that, to improve adherence, one should increase the apparent thickness of the support, and use a microscopically irregular layer on opposite surfaces of the substrate.

Thus, Kawano teaches away from the present invention.

Bernard et al –

As to Bernard, on page 5 of the Office action, in the paragraph related to claim 1, the Examiner states that the electrochemically active material in Bernard's negative electrode is nickel hydroxide. However, this is believed to result from an incorrect analysis of Bernard.

Applicant admits that nickel hydroxide is present in the negative electrode of Bernard. However, nickel hydroxide in the negative electrode is not present as an electrochemically active material. Indeed, nickel hydroxide is present as a protective layer around the particles of hydridable alloy. This protective layer prevents the hydridable alloy from being corroded due to the prolonged exposure to electrolyte which is a strong alkaline medium ([0007], [0009] and claim 1). Thus, nickel hydroxide is merely a protective compound but not an electrochemically active material. As a matter of fact, the electrochemically active material in the negative electrode is the hydridable alloy.

Further, Bernard teaches that nickel hydroxide in the negative electrode preferably constitutes only 1% to 4% by weight of the hydridable alloy [0011]. At most, Example 3 of Bernard discloses that nickel hydroxide in the negative electrode constitutes 6% by weight of the hydridable alloy. At such low levels, nickel hydroxide cannot be considered as an active material. An active material is generally the major compound in an electrode.

This statement is confirmed in the table at paragraph [0048] which indicates that the electrochemically active material represents 80% of the weight of the paste.

As mentioned in response to the first office action, Bernard teaches at paragraph [0014] a positive electrode which may be of the sintered type (thus not a non-sintered electrode as in the instant invention) or which may include a foam support (thus a 3D support and not a 2D support as in the instant invention). In the examples, the conductive support of the positive electrode is a nickel foam, thus a 3D support ([0050]).

In closing, Bernard does not disclose a positive non-sintered electrode comprising a two-dimensional conductive support. Further, it is silent regarding the composition of the binder used in the positive electrode. The use of styrene-acrylate is only disclosed in connection with the negative electrode, which is not what the present invention is about.

Kawano and Bernard -

As to the combination of Kawano et al and Bernard et al, it is clear that the embodiment of Kawano relied on by the examiner for teaching various aspects of claim 1 does not use a two-dimensional support. Nor does it include a binder which is a mixture of a cellulose and a styrene-acrylate copolymer.¹

As mentioned above, Kawano does not disclose:

¹ If the examiner intends to rely on the background discussion in Kawano et al for teaching a two-dimensional support, it should be noted that there is no teaching in Kawano et al that when using a two-dimensional support as in the prior art one would also use all of the layers, compositions, structures, etc. that Kawano uses in its three-dimensional configuration. If the examiner intends to argue that it would have been obvious in view of the Background discussion of Kawano to modify the preferred embodiment of Kawano to use a two-dimensional support instead of a three-dimensional support, applicants request that such a rejection be formally stated so that applicants can respond.

First, the skilled person would not consider Bernard which focuses on the negative electrode whereas the invention is limited to the positive electrode. The only teaching related to the positive electrode in Bernard can be found in paragraphs [0014] and [0050]. These paragraphs do not suggest a two dimensional conductive support for the positive electrode but rather a three dimensional support in the form of a nickel foam. Further, Bernard does not give any indication at all regarding the composition of the binder which would be suitable for the positive electrode.

Further, the skilled person would differentiate between a teaching concerning the negative electrode and a teaching concerning the positive electrode. Indeed, the positive electrode is subjected to a higher potential than the negative electrode. Thus, it is subjected to oxidizing conditions which cause degradation of the binder. The skilled person would not necessarily apply the teaching regarding the binder in the negative electrode ([0013]) to the binder of the positive electrode ([0014]). Further, if the skilled person had considered the examples in Bernard he would have been taught to use styrene/butadiene rubber (SBR) ([0048]-[0050]).

Moreover, Bernard does not suggest that a styrene-acrylate copolymer withstands oxidizing conditions. Thus, the skilled person could not predict that styrene-acrylate which is suitable for the negative electrode would also be suitable for a positive electrode.

Kawano and Vandayburg -

Vandayburg discloses a secondary electrochemical cell containing:
a positive electrode;
a negative electrode, and
an electrolyte which can be either an aqueous or non-aqueous electrolyte (col.6 1.20-21);
at least one of the positive electrode and the negative electrode includes an electrode mixture containing an active electrode material and a binder, wherein the binder contains polyacrylamide and at least one copolymer selected from the group consisting of carboxylated styrene-butadiene copolymer and styrene-acrylate copolymer. (claim 1)

Vandayburg discloses a current collector which may be a thin metal foil, thus a two-dimensional current collector (col.5 1.55).

Vandayburg requires that the binder contain both polyacrylamide and at least one copolymer selected from a carboxylated styrene-butadiene copolymer or a styrene-acrylate copolymer (Col.2 1.23-26, 1.52-57). However, the person skilled the art knows that that such a binder is not suitable for cells having an alkaline electrolyte. Indeed, polyacrylamide in the positive electrode is not stable and will generate nitrogen-containing compounds which are known to be responsible for the self-discharge observed in cells having an alkaline electrolyte. (See Journal of Power Sources 2004, 137(2), 317-321 submitted with the response to the previous Office action). Thus, Vandayburg et al does not teach the feature of the invention

whereby "*the binder is a mixture of a cellulose compound and a styrene-acrylate copolymer.*"

If the skilled person had combined the teachings of Kawano and Vandayburg he would have obtained a binder containing polyacrylamide which would be completely incompatible with the cell of the invention (and with Kawano's electrochemical cell which is also an alkaline cell). Applicant respectfully asserts that the skilled person would not consider the combination of Kawano and Vandayburg and that this represents an improper combination of references.

The additional references relied on by the examiner do not make up for the deficiencies discussed above with respect to Kawano, Bernard and Vandayburg.

In paragraph 6 at page 16 of the Office action, the examiner comments that the electrode polarity is not recited in claim 1. However, claim 1 recites that the electrochemically active material is a nickel hydroxide. This is tantamount to a recitation that the electrode is a positive electrode, since nickel hydroxide cannot be used as a negative electrochemically active material in a secondary electrochemical cell with an alkaline electrolyte. In any event, the positive polarity has now been explicitly recited in claim 1, with support found at paragraph [0025].

It flows from paragraph [0025] that if the negative electrode material comprises metal-hydride as an active material then nickel hydroxide is necessarily the active material of the positive electrode. This is also confirmed in paragraph [0082].

Additional Claims –

Claim 19 is added to state that the binder consists of the claimed mixture, thereby excluding other elements.

It is submitted that Kawano does not use a two-dimensional support for the reasons discussed in detail above. Claims 20-21 are added simply to emphasize the two-dimensional nature of the support in the present invention. Support for the term "plane-form" can be found at paragraph [0028] of the specification.

Claim 21 describes the support as being "substantially flat," with support at paragraph [0023].

Additional Prior Art -

In USP 5,514,488, a styrene-acrylate copolymer is used in the negative electrode of a lithium-ion battery (column 3, lines 28 and 54-55) whereas the instant invention focuses on the positive electrode of a battery containing an alkaline electrolyte. In USP 5,514,488, the active material to which the styrene-acrylate copolymer is combined is lithium-intercalating graphite (col. 2, lines 52-53) whereas in the invention the active material is nickel hydroxide. Further, the conductive support in USP 5,514,488 is a three-dimensional support (column 3, line 28) whereas the support in the invention is a two-dimensional support. The electrolyte in USP 5,514,488 is

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non-aqueous (col. 2, lines 25-26) whereas the electrolyte in the invention is an aqueous alkaline electrolyte.

USP 4,529,677 discloses a battery separator containing an acrylate copolymer binder (claim 1). It does not disclose an electrode containing an acrylate copolymer binder. The separator in USP 4,529,677 is said to be resistant to an exposure to an acidic medium (col. 5, lines 60-63). This is the reason why such a separator is advantageously used in a lead-acid battery (col. 9, line 51, and col.12, line 67) In the instant invention, the binder is exposed to a strong alkaline medium. The problem solved in USP 4,529,677 is to find a separator having an improved resistance in an acidic medium (col. 13, line 18, col. 5, line 63) and a good wettability in an acidic medium. The purpose of the instant invention is to improve the adherence of the positive active material to the 2D support. Thus, the problem in US 4,529,677 is very different from the problem of the instant invention_

US Appl. No. 10/349,949 (abandoned) is the same as the "Bernard" reference relied on by the examiner..

These references are not believed any more relevant to the claimed invention than the art already of record, but are brought to the attention of the examiner to be safe.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

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Respectfully submitted,

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